



Trends and Profitability Analysis of Garlic Cultivation in Haryana

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Abstract— Garlic is an important spice crop in India, valued for its culinary, medicinal and economic contributions. This study examines the growth trends, instability and profitability of garlic cultivation in Haryana over a 22-year period (1999–00 to 2020–21) using time-series data, compound annual growth rates (CAGR) and Cuddy-Della Valle Index (CDVI), the analysis revealed significant increases in area and production, while productivity growth remained moderate. Instability in garlic production decreased indicating greater production stability. Primary survey data from 30 farmers across key districts showed that garlic cultivation is economically viable, with an average gross return of ₹290,000/ha and net returns of ₹120,000/ha. Despite challenges such as market price fluctuations and pest management, government initiatives and improved agronomic practices have positively influenced garlic production and farmer incomes in Haryana.



Keywords— Garlic cultivation, Haryana, profitability, spice crops, farmer income

I. INTRODUCTION

Garlic (*Allium sativum* L.) is a globally significant spice crop, cultivated extensively for its distinctive flavor, high nutritional value, and diverse medicinal applications. As a member of the Alliaceae family, garlic has been utilized not only as a culinary ingredient but also as a therapeutic agent for centuries. Numerous studies have highlighted its bioactive compounds—particularly allicin—which are associated with antimicrobial, antioxidant, and cardiovascular health benefits (Lanzotti, 2006; Rahman, 2007). Due to these properties, garlic enjoys high consumer demand in both domestic and international markets, making it an economically important crop for farmers and agribusinesses alike. India is among the leading garlic-producing countries globally, contributing significantly to

world supply. The crop occupies a prominent position in India's horticultural sector, providing livelihood support to a large number of small and marginal farmers while also contributing to export earnings. According to the National Horticulture Board (2022), garlic production in India has shown consistent growth in recent years, reflecting both rising market demand and expanded cultivation. Within India, the state of Haryana has experienced notable growth in garlic production, with several districts emerging as major contributors to the crop's regional output. This expansion is largely supported by government-led initiatives, most prominently the launch of the National Horticulture Mission (NHM) in 2005–06, which aimed to accelerate horticultural development by improving infrastructure, providing input subsidies, and promoting

scientific cultivation practices (MoA&FW, 2020). Despite these positive developments, garlic cultivation in Haryana continues to face challenges related to production variability, market instability, and input cost fluctuations. The lack of consistent yield levels and unpredictable price movements expose farmers to economic uncertainty, which may affect their long-term interest in garlic farming. Furthermore, while government schemes have contributed to the expansion of horticulture in general, there is limited empirical evidence assessing their specific impact on garlic cultivation at the state or district level. Understanding the patterns of growth, the degree of instability, and the economic viability of garlic farming is therefore essential for designing more targeted interventions to improve farmer outcomes. In response to these gaps, this study undertakes a comprehensive evaluation of garlic cultivation in Haryana. It aims to analyze the growth trends in area, production and productivity over a defined period, with a focus on major garlic-producing districts. Additionally, it assesses the extent of instability in garlic cultivation across different years and regions, using established statistical methods. A key objective of the research is to conduct an in-depth economic analysis, including cost of cultivation, gross and net returns and benefit-cost ratios to evaluate the profitability of garlic farming under current market and policy conditions.

II. MATERIALS AND METHODS

Secondary data

The study was conducted in Haryana state. Time-series data for 22 years (1999-00 to 2020-21) on area, production and productivity of garlic were collected from different published and unpublished sources like, Department of Horticulture Govt. of Haryana, Directorate of Agriculture Govt. of Haryana, State Statistical Abstract of Haryana etc.

Selection of districts

Those districts were selected that was together contributed more than 60 percent share in total production of the concerned crop and provided in the table 1

Table 1: Selection of districts for garlic

Districts	Production (tonne)	% Share of production
Karnal	16078	38.91
Yamuna Nagar	7933	19.20
Jind	2447	5.92

Other districts	14862	35.97
Total	41321	100.00

Primary data

The primary data were collected through a personal interview method with the help of pre-tested schedule from the selected registered farmers under Bhavantar Bharpayee Yojna (BBY). For garlic crop, two districts Karnal and Yamuna Nagar were selected purposively on account of highest production under crop cultivation. Then, one highest production block was selected from each of the selected districts. From Karnal district, Indri block and from Yamuna Nagar district, Radaur block were selected. From each selected block, further one village was selected having maximum number of farmers registered under BBY for garlic crop. In this way from Indri block, Muradgarh village and from Radaur block, Rajheri village were selected. From each of the selected villages, 15 farmers were randomly selected and interviewed. Thus, a total of 30 farmers were selected for this study.

Analytical tools:

The Compound Annual Growth Rate (CAGR)

The CAGR was obtained using the formula

$$Y_t = Y_0 (1+r)^t \text{ ----- (1)}$$

Y_t = refers to area/production/yield of "t" time

Y_0 = refers to base year area/production/yield

The logarithmic transformation of equation (1) is given as,

$$\ln Y_t = \ln Y_0 + t \ln (1+r) \text{ ----- (2)}$$

where, Y_t is the value of the variable at t^{th} period for which growth of area/ production/ yield is calculated, r is the compound annual growth rate.

Now, let $(\ln Y_0) = \beta_1$ and $\ln (1+r) = \beta_2$, the above equation becomes $\ln Y_t = \beta_1 + \beta_2 t$

β_1 and β_2 are estimated through the Ordinary Least Square (OLS) method and the compound annual growth rate (r) is obtained by

$$r = (\text{antilog } \beta_2 - 1) \times 100 \text{ ----- (3)}$$

Instability Index (Cuddy-Della Valle Index)

The Coefficient of Variation (CV) is measure the variation over-estimates the level of instability in the time series data that are characterized by long term trends. The use of Cuddy-Della Valle Index (CDVI) corrects the coefficient of variation for the trend component in the time series data (Della Valle, 1979). So, the CDVI is used in the

present study to measure the instability in the area and production.

$$CDVI = CV \times \sqrt{(1 - \bar{R}^2)} \quad (4)$$

where, CDVI is the instability index in percent

$$CV = (\sigma / \bar{X}) \times 100$$

$\bar{R}^2$ is the coefficient of determination from a time trend regression adjusted for the number of degrees of freedom.

The ranges of instability are as follows:

Low instability = between 0 to 15

Median instability = greater than 15 and lower than 30

High instability = greater than 30 (Sihmar, 2014)

Trend analysis

The trend in area, production and productivity of selected crop were computed for the series data of last 30 years, i.e. 1991-92 to 2020-21. To trace the path of process different trend functions were used. Among the competitive trend functions, the best function was selected based on their goodness of fit adjusted for the number of degrees of freedom (measured in terms of $\bar{R}^2$ value and significance of the coefficients).

1. Linear function

This function assumes a linear relationship between X and Y. The goal of linear trend analysis is to determine how well the data fits this linear model and to make predictions based on this relationship.

The mathematical equation for a linear trend line (also known as regression line) is given by

$$Y_t = a + bX_t + \varepsilon_t$$

Where,

‘ Y_t ’ is the dependent variable (area or production or productivity),

‘ X_t ’ is the independent variable (time in years),

‘a’ is the intercept,

‘b’ is the regression coefficient,

‘ ε_t ’ is the error term.

The values of ‘a’ and ‘b’ were estimated by applying the ordinary least squares (OLS) approach

2. Quadratic function

This function shows curved relationship between Y and X, rather than the straight-line relationship assumed in linear trend analysis. Quadratic data function is useful where there is peak or trough in the data of past periods i.e., when there is a non-linear trend in the data that can be approximated by a quadratic function.

Quadratic fit (or quadratic regression) can be expressed by the following mathematical equation

$$Y_t = a + bX_t + cX_t^2 + \varepsilon_t$$

Where,

‘ Y_t ’ is the dependent variable (area or production or productivity),

‘ X_t ’ is the independent variable (time in years),

‘a’ is the intercept,

‘b’ and ‘c’ are regression coefficients of X,

‘ ε_t ’ is the error term

The values of ‘a’, ‘b’ and ‘c’ were estimated by applying the ordinary least squares (OLS) approach.

3. Logarithmic function

This equation reflects a logarithmic relationship between X and Y. It is commonly used when the rate of change in Y varies logarithmically with X i.e., Y changes by a certain proportion each time X increases by a constant ratio.

The equation for a logarithmic trend line (or logarithmic regression) is

$$Y_t = a + b \ln(X_t) + \varepsilon_t$$

Where,

‘ Y_t ’ is the dependent variable (area or production or productivity),

‘ X_t ’ is the independent variable (time in years),

‘a’ is the intercept,

‘b’ is the regression coefficient,

‘ ε_t ’ is the error term

The values of ‘a’ and ‘b’ were estimated by the method of ordinary least squares (OLS)

4. Exponential function

This function signifies an exponential relationship between X and Y. It is used when the growth or decay of Y is proportional to its current value, leading to rapid changes over time or across values of X.

The equation for an exponential trend line (or exponential regression) is typically represented as

$$Y_t = a \cdot e^{bX_t} + \varepsilon_t$$

Where,

‘ Y_t ’ is the dependent variable (area or production or productivity),

‘ X_t ’ is the independent variable (time in years),

‘a’ is the coefficient (also known as the initial value or constant multiplier),

'b' is the exponent (also known as the growth rate or decay rate),

'e' is the base of the natural logarithm, approximately equal to 2.71828.

The values of 'a' and 'b' were estimated by applying the ordinary least squares (OLS) approach.

Selection of the suitable function was done by using values of adjusted R-square.

Adjusted R² – Criteria

It explains the variation of dependent variable due to variation in independent variable in the model. Assumption is that every independent variable in the model explains the variation in the dependent variable. But in reality, some dependent variables are not explained by some independent variables.

The coefficient of determination (R²) gives some information about the goodness of fit of a model. In regression, the R², or the coefficient of determination is a statistical measure of how well the regression line approximates the real data points. The value of R² lies between 0 and 1. The R² value of 1.0 indicates that the regression line perfectly fits the data i.e., model explains all variation of the dependent variable. It provides a measure of how well outcomes are likely to be predicted by the model. Mathematically R-square is given as sum of residuals (SSres) divided by total sum of squares (SStot) and then subtract it from 1. Here, total variation is measured by SStot. SSres measures unexplained variation and SSreg measures explained variation.

$$R^2 = 1 - \frac{\text{Error sum of square}}{\text{Total sum of square}} = 1 -$$

$$\frac{\sum_{t=1}^n (Y_t - \hat{Y}_t)^2}{\sum_{t=1}^n (Y_t - \bar{Y})^2}$$

$$R^2 = 1 - \frac{SS_{res}}{SS_{tot}}$$

$$R^2 = \frac{SS_{reg}}{SS_{tot}}$$

Where,

Y_t is the actual value,

$\hat{Y}_t$ is the predicted value,

$\bar{Y}$ is the mean value.

Adjusted R² ($\bar{R}^2$) measures the proportion of variance than can only be explained by independent variables that significantly contribute to the explanation of the dependent variable. In regression analysis, it penalizes use of independent variables that not help in predicting the dependent variable.

Mathematically, adjusted R-squared can be computed in terms of sum of squares. The degree of

freedom is the only difference between R-square and Adjusted R-square.

$$\bar{R}^2 = 1 - \frac{SS_{res}/df_e}{SS_{tot}/df_t}$$

In the above equation, df_t is degrees of freedom (n-1) of estimate of population variance of the dependent variable and df_e is degrees of freedom (n-p-1) of estimate of population error variance. Adjusted R² is calculated by using R² value as follows

$$\bar{R}^2 = 1 - \frac{(1-R^2)(n-1)}{n-p-1}$$

Where,

R² is the sample R-square,

p is number of independent variables,

n is total sample size.

Cost Concept

To calculate cost for major vegetables CACP (Commission for Agricultural Costs and Prices) cost concept were used (Kumar et al. 2019).

Cost A1 = Value of hired human labour + Value of hired and owned bullock labour + Value of hired and owned machine labour + Value of seed (both farm or purchased seed) + Value of manures and fertilizers (owned and purchased) + Depreciation + Irrigation charges + Land revenue + Interest on working capital + Miscellaneous expenses

Cost A2 = Cost A1 + rent paid for leased in land

Cost B1 = Cost A1 + interest on working capital (excluding land)

Cost B2 = Cost B1 + rental value of owned land + rent for leased in land

Cost C1 = Cost B1 + imputed value of family labour

Cost C2 = Cost B2 + imputed value of family labour

Cost C3 = Cost C2 + 10 per cent of Cost C2 as management cost

Result and Discussion

Growth in area, production and productivity of garlic in Haryana

The table 2 detailing the growth rates of area, production, and productivity of garlic in Haryana from 1999 to 2021 provides valuable insights into the agricultural trends across different districts, including Karnal, Yamuna Nagar, Jind, Other districts, and the overall state of Haryana. The Compound Annual Growth Rate (CAGR) values represent the average annual growth rate over the period, while the significance levels indicate whether these growth rates are statistically significant at the 1 per cent

level (p -value < 0.01) and 5 per cent level (p -value < 0.05). The results demonstrate varied growth trends across districts and overall for Haryana. In terms of area, Karnal showed a growth rate of 2.73 per cent, Yamuna Nagar had a higher growth rate of 6.20 per cent and Jind exhibited the highest growth rate at 9.62 per cent. Other districts demonstrated a moderate growth rate of 3.70 per cent, while Haryana as a whole experienced an overall growth rate of 4.07 per cent. This indicates that Jind showed the most significant expansion in area, with Yamuna Nagar and other districts also contributing notably to the growth in garlic cultivation. Regarding production, the highest growth was observed in Jind, with a CAGR of 12.64 per cent, followed by Yamuna Nagar at 9.49 per cent. Karnal showed a more

moderate growth rate of 4.61 per cent, while Other districts and Haryana saw respective growth rates of 5.76 per cent and 6.13 per cent respectively. Haryana as a whole experienced a relatively strong increase in production, indicating steady growth across the state. For productivity, Karnal had a CAGR of 1.83 per cent, Yamuna Nagar showed a more substantial increase at 3.10 per cent, and Jind had a growth rate of 2.75 per cent. Other districts showed a productivity growth of 1.99 per cent, while Haryana overall had a growth rate of 1.98 per cent. Yamuna Nagar led in productivity growth, reflecting efficient cultivation practices, followed by the other districts contributing positively to overall state productivity.

Table 2: Growth rates of area, production and productivity of garlic in Haryana: 1999-2021

Aspect	Period	Karnal		Yamuna Nagar		Jind		Other districts		Haryana	
		Mean	CAGR	Mean	CAGR	Mean	CAGR	Mean	CAGR	Mean	CAGR
Area (ha)	Overall Period	883.05	2.73**	618.36	6.20**	134.36	9.62**	1525.95	3.70*	3175.36	4.07**
Production (tonne)	Overall Period	8676.64	4.61**	5955.41	9.49**	1284.27	12.64**	13358.55	5.76**	28956.68	6.13**
Productivity (t/ha)	Overall Period	9.91	1.83**	9.5	3.10**	9.59	2.75	8.71	1.99**	9.13	1.98**

Note 1: CAGR = Compound Annual Growth Rate (per cent).

Note 2: **, * are significant at 1 and 5 per cent respectively.

Note 3: Data of garlic are available from the year 1999-00. So only overall period has taken from 1999 to 2021

Kumar et al (2019) concluded in his studies that growth in the area, production and yield of garlic in Haryana vis-à-vis India was estimated using the compound growth function. The necessary secondary data were collected for a period of 27 years from 1990-91 to 2016-17. During 1990-91 to 2016-17, in Haryana growth rates showed a significant positive growth in area, production and yield under garlic. Likewise, India as a whole country also showed a significant positive growth in area, production and yield under garlic. Lal and Kait (2021). Also indicate the similar pattern in growth in area, production and productivity. The results indicate that there is a significant positive growth rate of 2.20%, 4.50% and 2.20% in the area, production and productivity of ginger in the district of Panchkula.

Trends in area, production and productivity of garlic in Haryana

From figure 1 the trends in area, production and productivity of garlic were presented. The trend analysis of garlic cultivation in Haryana from 1999–2000 to 2020–21 revealed significant growth in production and productivity, while the area under cultivation showed moderate and slightly fluctuating behaviour. The polynomial equation for area has an R^2 value of 0.76, indicating that 76 per cent of the variation in the area trend is explained by time, suggesting moderate growth in the area under garlic cultivation.

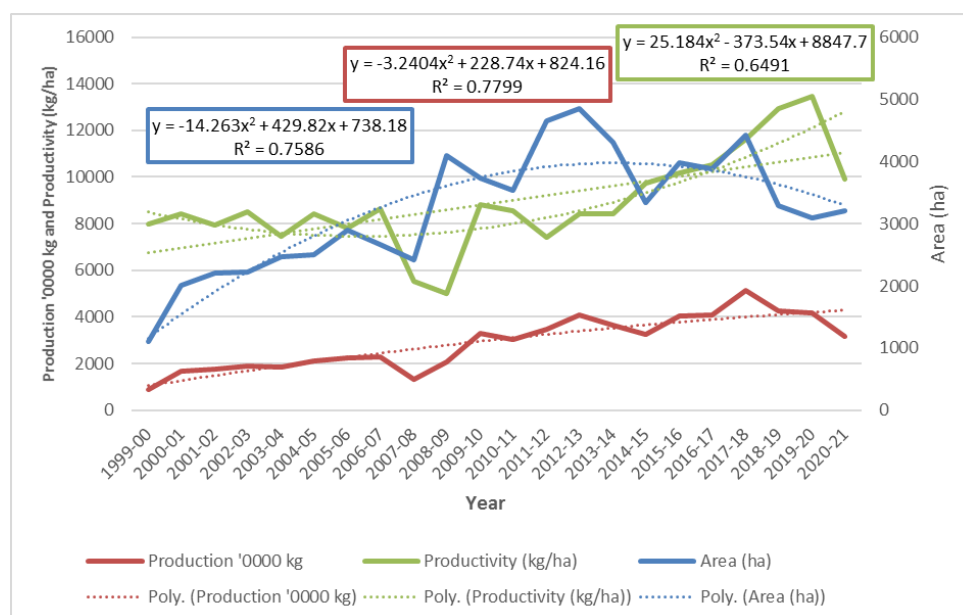


Fig.1: Trends in area, production and productivity of garlic in Haryana

The polynomial equation for production has an R^2 value of 0.78, showing that 78 per cent of the variation in the production trend is explained by time, reflecting a significant increase in garlic production during the study period. For productivity, the polynomial equation has an R^2 value of 0.65, indicating that 65 per cent of the variation in productivity is explained by time, showing a relatively strong upward trend in productivity. The R^2 values for area, production, and productivity suggest that the variations in these trends are statistically significant ($P < 0.01$), with productivity showing a particularly strong correlation with time, followed by production and area.

Instability in area, production and productivity of garlic in Haryana

The data for the instability analysis of area, production, and productivity across districts of Haryana based on the Coefficient of Variation (CV) and Cuddy-Della Valle Index (CDVI) given in Table 3. In terms of area instability, during the period, very high instability was observed in Yamuna Nagar and Jind (CV: 51.06%, CDVI: 42.51%) and (CV: 57.51%, CDVI: 38.90%), indicating volatile land allocation in the early years.

Table 3: Instability in area, production and productivity of garlic in Haryana: 1991-2021 (per cent)

Aspect	Period	Karnal		Yamuna Nagar		Jind		Other districts		Haryana	
		CV	CDVI	CV	CDVI	CV	CDVI	CV	CDVI	CV	CDVI
Area	Overall Period	23.83	18.38	51.06	42.51	57.51	38.90	37.98	33.18	32.06	24.09
Production	Overall Period	39.69	27.53	64.35	44.35	71.49	43.44	40.49	27.95	39.43	19.28
Productivity	Overall Period	32.80	31.36	30.36	21.14	49.91	50.03	19.89	15.84	24.88	21.48

Note 1: Period-I: (1991-92 to 2004-05); Period-II: (2005-06 to 2020-21); and **Overall period:** (1991-92 to 2020-21).

Note 2: CV = Coefficient of Variation; CDVI = Cuddy-Della Valle Index.

Note 2: Data of garlic are available from the year 1999-00 so only overall period is taken from 1999 to 2021

Whereas Karnal (CV: 23.83%, CDVI: 18.38%), other districts (CV: 37.98%, CDVI: 33.18%), and Haryana (CV: 32.06%, CDVI: 24.09%). recorded medium area instability

In terms of production, Karnal (CV: 39.69%, CDVI: 27.53%) and Haryana (CV: 39.43%, CDVI:

19.28%). Other districts (CV: 40.49%, CDVI: 27.95%) recorded medium instability. However, instability sharply declined in the period. Yamuna Nagar (CV: 64.35%, CDVI: 44.35%) and Jind (CV: 71.49%, CDVI: 43.44%), high production instability in the overall period.

The instability analysis of garlic productivity across the major districts of Haryana showed medium instability in Karnal (CV: 32.80%, CDVI: 31.36%), Yamuna Nagar (CV: 30.36%, CDVI: 21.14%), Jind (CV: 49.91%, CDVI: 50.03%), Haryana (CV: 24.88%, CDVI: 21.48%), and other districts (CV: 19.89%, CDVI: 15.84%).

Cost in garlic cultivation

The cost concepts involved in garlic cultivation in the study area are presented in Table 4. Cost A1 in the cultivation of garlic was ₹434,971.12 per hectare. Cost A1 includes all the paid-out costs from the farmer's side, covering expenses such as seeds, fertilizers, pesticides,

labor, and irrigation. Cost A2 was ₹523,582.37 because the farmers had taken land on rent for garlic cultivation in the study region. Cost B1 was calculated as ₹434,971.12 per hectare, corresponding to Cost A1, while Cost B2, which includes both the operational cost and the rent for the land, was observed to be ₹523,582.37. Cost C1, on an overall average, was ₹434,971.12 per hectare, which is equivalent to Cost A1 and Cost B1. Further, Cost C2, was calculated to be ₹523,582.37 per hectare, matching Cost A2 and Cost B2. For Cost C3, which accounts for management-related overheads, it equals Cost C2 plus 10 per cent of Cost C2, resulting in a total of ₹564,918.18 per hectare for the overall farm size.

Table 4: Cost of cultivation in garlic (₹/ha)

S.no.	Particular	Cost
1	Cost A1	434971.12
2	Cost A2	523582.37
3	Cost B1	434971.12
4	Cost B2	523582.37
5	Cost C1	434971.12
6	Cost C2	523582.37
7	Cost C3	564918.18

Cost and returns of garlic cultivation

The distribution of costs and returns per hectare for garlic farming is given in Table 5. The gross returns per hectare from garlic cultivation were estimated at ₹693,550, with the return over variable costs amounting to

₹280,191.88. The net return per hectare from garlic was ₹128,631.82. The average production was 130 quintals per hectare, with a total cost of cultivation of ₹564,918.18 per hectare. Of this, variable costs amounted to ₹413,358.12 (73.17%) of the total cost. Seed costs were ₹135,850 (24.05%), which is a

Table 5: Cost and returns of garlic production in Karnal and Yamuna Nagar districts of Haryana

Sr. No.	Inputs	No./Quantity per ha	Value (₹/ha)	Per cent of total cost
1	Preparatory tillage	8	15684.00	2.78
2	Pre-sowing irrigation		1370.85	0.24
3	Seed (Kg)/Nursery raising	905	135850.00	24.05
4	Seed treatment		0.00	0.00
5	Sowing/Transplanting		30875.00	5.47
6	Ridging and layout operation		17043.00	3.02
7	FYM (q)	330	19760.00	3.50
8	Fertilizer nutrients		0.00	0.00
	a)Urea(Kg/ha)	310	1857.00	0.33
	b)DAP/SSP/NPK(Kg/ha)	311	8398.00	1.49
	c) Muriate of potash(Kg/ha)	123.5	3829.00	0.68

	d)ZnSO ₄ (Kg/ha)	9	1111.50	0.20
	e)Sulphur (Kg/ha)	24.7	1235.00	0.22
	f)Other nutrient(Kg/ha)	95	7657.00	1.36
	Total Fertilizer Invest		24087.50	4.26
9	Fertilizer application cost		2000.70	0.35
10	Irrigation	8	11077.95	1.96
11	Hoeing/Weeding		0.00	0.00
	(a)Chemical	1	3952.00	0.70
	(b)Manual	2	24700.00	4.37
12	Earthing up		0.00	0.00
13	Plant protection	7	25815.00	4.57
14	Harvesting/Picking charges		72865.00	12.90
15	Miscellaneous		1235.00	0.22
	Total (1 to 15)		386316.00	68.38
16	Interest on working capital @7%		27042.12	4.79
17	Variable cost		413358.12	73.17
18	Packaging charges		2470.00	0.44
19	Transportation		17290.00	3.06
20	Management charges @10%		41335.81	7.32
21	Risk factor @ premium of MBBY		1853.00	0.33
22	Rental value of land		88611.25	15.69
23	Total cost		564918.18	100.00
24	Production(q/ha)	130	0.00	
25	Price Received (₹/q)		5335.00	
26	Gross Return(₹/ha)		693550.00	
27	Return over variable cost		280191.88	
28	Net return(₹/ha)		128631.82	
29	Cost of Production (₹/q)		4345.52	
30	B :C Ratio		1.23	

significant portion of the total costs due to the use of high-quality seed. Farm yard manure costs were ₹19,760 (3.50%), while fertilizer costs stood at ₹24,087.50 (4.26%). Plant protection chemicals accounted for ₹25,815 (4.57%), and interest on working capital was ₹27,042.12 (4.79%). Packaging charges were ₹2,470 (0.44%), and transportation costs were ₹17,290 (3.06%). Management charges, calculated at 10% of the variable cost, were ₹41,335.81 (7.32%), and the rental value of land was ₹88,611.25 (15.69%). The risk factor, calculated as a premium for the MBBY (Mukhya Mantri Bagwani Bima Yojna), was ₹1,853 (0.33%) of the total cost, providing insurance coverage for

the farmers under the scheme. The cost of production per quintal was ₹4,345.52. The Benefit-Cost Ratio (B:C ratio) was 1.23, indicating that garlic cultivation in the study area was profitable, with every rupee spent yielding a return of ₹1.23.

III. CONCLUSION

The study on garlic cultivation in Haryana over a period revealed significant changes in area, production, and productivity. Overall, Haryana witnessed a CAGR of 4.07 per cent in area, 6.13 per cent in production, and 1.98 per

cent in productivity, with the most substantial growth observed in Jind district. In terms of area and production instability, during the period, very high instability was observed in Yamuna Nagar and Jind districts. At the farm level, the cost of cultivation per hectare was ₹5.64 lakh (Cost C3), yielding an average production of 130 quintals and gross returns of ₹6.93 lakh, resulting in net returns of ₹1.28 lakh per hectare. These findings underscore the importance of policy interventions like NHM in enhancing both economic returns and production stability in garlic farming while also emphasizing the need for continued investment in infrastructure and farmer support systems.

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